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(54) Arrester and manufacturing method thereof

(57) An arrester comprises at least one of non-linear resistors (1) mainly consisting of a zinc oxide, terminal electrodes (2) disposed to both end portions of the non-linear resistor (1) to be electrically conductive so as to construct an internal element (3), an insulative woven fabric (4) impregnated with an insulation resin which is hardened by being heated, the insulative woven fabric (4) being applied so as to surround the internal element (3), and a polymer resin integrally molded to the internal element (3) surrounded by the insulative woven fabric (4). The arrester is manufactured by conductively joining the terminal electrodes (2) to both end portions of the non-linear resistor (1), covering a surrounding of the internal element (3) with an insulative woven fabric (4), arranging the integrated internal element (3) in a mold, injecting a polymer resin mixed with a main liquid, a hardening agent and a coloring agent into the mold, and hardening the polymer resin in the mold so as to form an insulator.

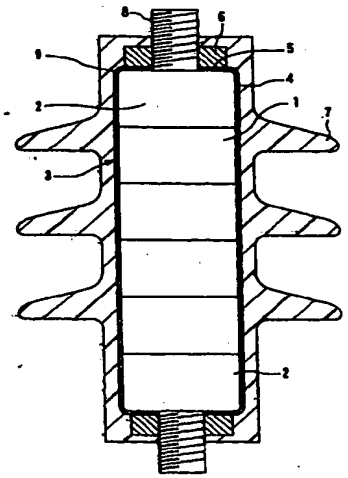

FIG. 1

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an arrester which has a compact size and which can make considerably small a danger of explosion when an abnormal current flows and also relates to a method of manufacturing such arrester.

[0002] In general, in a case where an abnormal voltage (lightning surge) is generated in a power system by a thunderbolt for example, in order to protect the power system and power equipment from the abnormal voltage, an arrester is used. A non-linear resistor is used as the arrester and shows an insulative characteristic under a normal voltage and shows a low resistance characteristic when an abnormal voltage is applied.

[0003] Moreover, the arrester is connected between a power system and a ground, and in the case where an abnormal voltage is generated, a discharge current flows through the arrester, and thus, the abnormal voltage is limited. Then, when the voltage returns to a normal state, a discharge is immediately stopped, and thereafter, the arrester comes back to the initial insulative state.

[0004] In the arrester described above, its internal element is constructed in the following manner. More specifically, a plurality of non-linear resistors consisting mainly of a zinc oxide are formed in the form of lamination, and then, terminal electrodes are conductively joined to axially upper and lower end portions of the non-linear resistor, and further, in order to prevent a shift in their diametrical direction, a plurality of insulating rods are uniformly arranged in a diametrical direction, and thus, the upper and lower ends of the non-linear resistor are fastened and fixed by an insulative nut.

[0005] The internal element thus assembled is received in an insulating container, and then, an upper end portion of the internal element is covered with a cap via a spring, and thereafter, an axial stress is applied so that the above-described internal element is fixed to the center of the insulating container.

[0006] The insulating container mentioned above is made of a ceramic or a polymer resin, and in particular, the arrester using an insulating container made of a polymer resin is called as a polymer type arrester. As described above, there is a method of fixing the non-linear resistor by using the insulating rod, and besides, for example, there are a method of fixing the non-linear resistor by using an insulating tape as disclosed in Japanese Patent Laid-open Publication No. HEI 1-255437, and a method of fixing the non-linear resistor by using an insulating net as disclosed in Japanese Patent Laid-open Publication No. HEI 10-55904.

[0007] However, the conventional polymer type arrester has the following problem. That is, in the case of assembling an internal element using an insulating rod, a worker must manually arrange and assemble individual parts, for example, a plurality of non-linear resistors and terminal electrodes of upper and lower end portions of the non-linear resistor, and further, in order to make these parts into a unit, an insulating rod, a nut and the like are required. Moreover, in the case of receiving the internal element in a polymer insulator, the internal element must be fixed, and further, in order to fix the internal element by applying an axial stress thereto, a spring and a cap are used. For this reason, there are unstable factors in assembling.

[0008] Further, in the case where the non-linear resistor is fixed by using a tape or net, a partial discharge is generated in a contact surface of the non-linear resistor, and then, a peripheral polymer resin receives a damage, and for this reason, there is a possibility that a breakdown takes place. In addition, in the case where a current exceeding the limit flows through the arrester, in order to release a generated gas from the side, the polymer resin, tape or net positioning on the side is broken. Thus, there is a possibility that a broken piece of the non-linear resistor is scattered to the outside of the arrester.

[0009] Furthermore, a polymer material is deteriorated depending upon a working environment, and for this reason, it is necessary to improve a weather (weathering) resistance with respect to a temperature, a light such as ultraviolet rays, salt damage, and a dust.

SUMMARY OF THE INVENTION

[0010] A primary object of the present invention is to substantially eliminate defects or drawbacks encountered in the prior art mentioned above and to provide an arrester which can reduce the number of components so as to improve a manufacturing easiness, has a compact size, and further, can prevent an explosion and scattering even if a ground fault current exceeding the limit flows.

[0011] Another object of the present invention is to provide an arrester which can prevent a generation of partial discharge, can maintain a reliability for a long period, and further, has an excellent weather resistance.

[0012] A further object of the present invention is to provide a method of manufacturing an arrester of the characters mentioned above in an improved manner.

[0013] These and other objects of the present invention can be achieved by providing, in one aspect, an arrester comprising:

at least one of non-linear resistor mainly consisting of a zinc oxide;
terminal electrodes disposed to both end portions of the non-linear resistor to be electrically conductive so as to construct an internal element;
an insulative woven fabric impregnated with an insulation resin which is hardened by being heated, said insulative woven fabric being applied so as to

surround the internal element; and

a polymer resin integrally molded to the internal element surrounded by the insulative woven fabric.

[0014] In preferred embodiments, the insulative woven fabric is formed into a tubular shape by weaving an insulative single yarn or twist yarn to be continuous endlessly in a circumferential direction thereof. The single yarn or twist yarn constituting the insulative woven fabric has an angle, from two different directions, set to a range from 30 to 160°. The weaving interval of the single yarn or twist yarn constituting the insulative woven fabric is set to a range from 0.5 to 5 mm.

[0015] The insulative woven fabric is formed with a pressure releasing opening portion at a position in the vicinity of axially upper and lower peripheral edge portions of the non-linear resistor or formed with a pressure releasing weak-point portion at a position in the vicinity of axially upper and lower peripheral edge portions of the non-linear resistor.

[0016] The polymer resin contains a filler by 0.5 to 40 weight %, and the filler is made of at least one of SiO_2 and TiO_2. The polymer resin contains Pt, Fe, Ni, Ca, Mn, Na, K and Mg by 1 to 50ppm. The polymer resin has, a rubber hardness of 30 to 60. The polymer resin has a low molecular weight of 2000 to 8000. The polymer resin has a tracking resistance of 3.5 to 5.5kV.

[0017] The polymer resin comprises a main liquid and a hardening agent in a ratio of the main liquid to the hardening agent of from 1:0.9 to 1:1.1. The polymer resin may comprise a main liquid, a hardening agent and a coloring agent, the coloring agent being added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%.

[0018] According to the above aspect of the present invention, one or plural non-linear resistors consisting mainly of a zinc oxide are laminated, and then, is integrated by the insulative woven fabric together with a terminal electrode. These components are collectively molded out of a polymer resin so as to construct an arrester. Therefore, it is possible to dispense parts for fixing these components and to provide the arrester which has a compact size.

[0019] Even if the non-linear resistor causes a through breakdown by an excessive operation, and further, a gas is generated by a generation of arc and an internal pressure rises up, the surrounding of the internal element is covered with the insulative woven fabric. Therefore, it is possible to prevent the arrester from being explosively scattered. Moreover, since the non-linear resistor is joined and no partial discharge is generated, it is possible to prevent an insulator made of a polymer resin from being deteriorated.

[0020] Furthermore, since an angle of the single yarn or twist yarn is set to a range from 30 to 160°, a sufficient strength can be obtained. The angle is preferably 60°, and if the angle is less than 30° and exceeds 160°, a fiber slips, and a sufficient strength cannot be obtained.

[0021] Since the interval of the single yarn or twist yarn is set to a range from 0.5 to 5 mm, a preferable pressure releasing characteristic and a sufficient strength can be obtained. If the interval exceeds 5 mm, a sufficient strength can not be obtained, and if the interval is less than 0.5 mm, a generated gas is not released. Hence, an improvement effect can not be obtained.

[0022] Furthermore, even if the insulative woven fabric is woven in a state that its interval is shortened, the insulative woven fabric is provided with an opening portion at a position corresponding to each of the upper and lower end portions of the non-linear resistor. Otherwise, the insulative woven fabric is provided with a weak-point portion, and the weak-point portion includes a folded portion of the insulative woven fabric, a notch portion of the insulative woven fabric, a portion in which a fiber is coarsely woven and an insulating resin portion thinner than other portions. Accordingly, in the case where an arc is generated by an excessive operation, a short-circuit current flows through the non-linear resistor, the insulative woven fabric or an interface of the insulator, and therefore, the arc flows to the upper and lower terminal electrodes via the opening portion or the weak-point portion of the insulative woven fabric while a gas generated therein vertically releasing. As a result, even if an excessive current flows, the non-linear resistor is held in the insulative woven fabric, and it is possible to prevent explosive scattering.

[0023] Since the polymer resin contains a filler by 0.5 to 40%, an elasticity as a polymer resin is maintained while a weathering resistance being improved. The content of the filler is preferably 20 to 38%. Further, if less than 0.5%, 24 hours takes to recover a water repellent performance of the insulator made of the polymer resin, and therefore, a weather resistance is not improved. Moreover, if the content exceeds 40%, an elasticity of the insulator made of the polymer resin is lost.

[0024] Furthermore, since the polymer resin contains Pt, Fe, Ni, Ca, Mn, Na, K and Mg by 1 to 50ppm, an elasticity as a polymer resin is maintained while a weather resistance being improved. The content is preferably 5 to 30ppm, and if less than 1ppm, 20 hours takes to recover a water repellent performance of the insulator made of the polymer resin. For this reason, the weather resistance is not improved. Moreover, if the content exceeds 50ppm, an elasticity of the insulator made of the polymer resin is lost.

[0025] Since the polymer resin has a rubber hardness of 30 to 60, it is possible to improve a dust resistance characteristic. In this case, if a rubber hardness is less than 30, it is difficult to maintain a shade-shape of the insulator. Moreover, if the rubber hardness exceeds 60, the insulator is easy to be damaged.

[0026] Since the polymer resin has a low molecular weight of 2000 to 8000, it is possible to obtain a preferable short-circuit characteristic and weather resistance.

In this case, if the polymer resin has a molecular weight of 2000 or less and exceeds a molecular weight of 8000, neither preferable short-circuit characteristic nor weathering resistance is obtained.

[0027] Still furthermore, since the polymer resin has a tracking resistance of 3.5 to 5.5kV, the preferable short-circuit characteristic and weather resistance can be obtained. If the tracking resistance is less than 3.5kV, during a weathering resistance test, a leakage current on the surface of the pleat portion of the insulator increased. Therefore, it has found that there is a problem in a lifetime characteristic. Moreover, if the tracking resistance exceeds 5.5kv, during the weather resistance test, a generation of corona discharge has been confirmed.

[0028] A factor of generating the corona discharge is not still clarified. However, when the tracking resistance becomes high, a charge is easy to be stored on the surface of the pleat of the insulator, and when the charge exceeds a certain limit, a corona discharge is generated. When the corona discharge is generated, an organic matter is carbonized, and thus, a lifetime is shortened.

[0029] Furthermore, a ratio of the main liquid to the hardening agent ranges from 1:0.9 to 1:1.1, and thereby, preferable mixing condition is obtained. The ratio is preferably of 1:1, and if the ratio diverges from a range from 1:0.9 to 1:1.1, a preferable mixing condition is not obtainable.

[0030] Since a coloring agent is added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%, the insulator is colored, so that the interior of the arrester can be protected from an ultraviolet ray. In this case, if the coloring agent is less than 0.5wt%, an effect as a coloring agent is not obtained. Morecver, if the coloring agent exceeds 2.0wt%, the weather resistance is deteriorated.

[0031] In another aspect of the present invention, there is also provided a method of manufacturing an arrester comprising the steps of:

preparing at least one non-linear resistor mainly consisting of a zinc oxide and terminal electrodes;
conductively joining the terminal electrodes to both end portions of the non-linear resistor so as to construct an internal element;
covering a surrounding of the internal element with an insulative woven fabric which is impregnated with an insulating resin hardened by being heated so as to integrally form the internal element and the insulative woven fabric;
arranging the integrated internal element in a mold;
injecting a polymer resin mixed with a main liquid, a hardening agent and a coloring agent into the mold; and
hardening the polymer resin in the mold so as to form an insulator.

[0032] In preferred embodiment of this aspect, the injection molding is carried out by using an injection molding machine including material tanks in which the main liquid, the hardening agent and the coloring agent are stored and also including a mixing container into which the main liquid, the hardening agent and the coloring agent are mixed, the mixing container having a tubular structure in which a plurality of rotating blades are disposed.

[0033] A surface of an integrated product formed by covering the surrounding of the internal element with the insulative woven fabric, which is impregnated with the insulating resin hardened by being heated, is previously subjected to a primer treatment before molding the polymer resin. The polymer resin comprises a main liquid and a hardening agent in a ratio of the main liquid to the hardening agent of from 1:0.9 to 1:1.1. The polymer resin comprises a main liquid, a hardening agent and a coloring agent, the coloring agent being added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%.

[0034] According to this aspect, in the manufacturing method of the arrester, the terminal electrodes are conductively joined to both end portions of the laminated non-linear resistors so that an internal element is constructed, and then, the surrounding of the internal element is covered with the insulative woven fabric which is impregnated with an insulating resin hardened by being heated so that the internal element and the insulative woven fabric are integrated. Thereafter, the integrated internal element is arranged in a mold, and further, a polymer resin mixed with a main liquid, a hardening agent and a coloring agent is injected into the mold, and is hardened in the mold so as to form an insulator. Therefore, it is possible to improve a manufacturing efficiency and to provide an arrester having a high quality.

[0035] The nature and further characteristic features of the present invention will be made more clear from the following descriptions made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] In the accompanying drawings:

Fig. 1 is a cross sectional view showing an arrester according to one embodiment of the present invention;
Figs. 2A, 2B and 2C are views to explain a procedure of a manufacturing method of an arrester according to one embodiment of the present invention; and
Fig. 3 is a cross sectional view showing a pipe-like mixing container shown in Fig. 2C.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] Embodiments of the present invention will, be described hereunder with reference to the accompanying drawings.

[0038] Fig. 1 is a cross sectional view showing an arrester according to one embodiment of the present invention.

[0039] As shown in Fig. 1, a plurality of non-linear resistors 1 consisting mainly of a zinc oxide are conductively connected to each other via a conductive bonding agent, and the plural non-linear resistors 1 are stacked and formed into a laminated body, and further, terminal electrodes 2 are conductively joined to axially upper and lower end portions of the laminated body, thereby constructing an internal element 3.

[0040] The internal element 3 is coated with an insulative woven fabric 4 in which an insulative resin hardened by being heated is impregnated, and then, axially upper and lower end portions of the insulative woven fabric 4 is interposed and fixed between an upper (outer) surface portion 5 of the terminal electrode 2 and a holding metal fitting 6, and these components are integrated as a unit. Thereafter, a polymer resin is molded into the integrated internal element 3, and in this manner, an insulator 7 is formed.

[0041] The non-linear resistors 1 are a zinc oxide sintered body having a non-linear resistance. These non-linear resistors 1 are conductively connected so as to be form into a laminated body, or in the case of conductively joining the zinc oxide sintered bodies to each other, in order to improve a joining strength, a metallic electrode having a conductivity is interposed between the zinc oxide sintered bodies, and then, these components are laminated by being conductively joined so as to form a laminated body. In this embodiment, a plurality of non-linear resistors 1 have been laminated by conductive connection. However, without limiting the above-described construction, the laminated body may be composed of one non-linear resistor.

[0042] Moreover, the insulative woven fabric 4 covering the internal element 3 is made in the following manner. A thermosetting resin, which is an insulative resin such as an epoxy resin, a phenol resin and a polyester resin, is impregnated in an insulating fabric composed of a warp and a weft such as an aramid fiber, an alumina fiber, a polyester fiber or the like. Further, the insulative woven fabric 4 has a sheet-like shape in general. In the arrester of this embodiment, an insulative single yarn or twist yarn is woven, and then, the weaving is made continuously endlessly in its circumferential direction, and further, a cylindrical shape woven fabric is used. In the single yarn or twist yarn constituting the insulative woven fabric 4, an angle from two different directions is set to a range from 30 to 160°, and its interval is set to a range from 0.5 to 5 mm.

[0043] A screw portion (member) 8 formed with a screw (threaded) portion is provided for the upper surface portion 5 of the terminal electrode 3. A holding metal fitting 6 such as washer and nut is screwed into the screw portion 8 so that both upper and lower end portions of the insulative woven fabric 4 are fastened and fixed by the holding metal fitting 6. The terminal electrode 2 is formed with an R-portion 9 at its corner portion, that is, edge portion of the upper surface portion 5 thereof.

[0044] A silicon resin using dimethyl polysiloxan as a main component is used as a polymer resin for forming the insulator 7. The silicon resin contains a filler made of at least one material of SiO_2 and TiO_2 by 0.5 to 40%. Moreover, the substances containing Pt, Fe, Ni, Ca, Mn, K and Mg in the silicon resin as a catalyst by 1 to 50ppm may be used. The polymer resin is set so as to have a rubber hardness ranging from 30 to 60, a low molecular weight such as of 2000 to 8000, and a tracking resistance of 3.5 to 5.5kV.

[0045] The arrester of the characters mentioned above will operate or function as follows.

[0046] First, the internal element 3 of the lightning arrester is covered with the insulative woven fabric 4 so as to be integrated as a unit, so that assembling can be very simplified, and also, a work can be readily performed. The Internal element 3 is fixed by using the insulative woven fabric 4 in place of an insulating rod, an insulating nut and a spring, so that the number of components can be reduced. Therefore, it is possible to readily obtain the internal element 3 which is stable in its structure and has less dispersion in its characteristics.

[0047] More specifically, the plurality of non-linear resistors 1 consisting mainly of a zinc oxide are laminated and are integrated with the insulative woven fabric 4 together with the terminal electrodes 2. Further, these components are collectively molded out of a polymer resin so as to form an insulator 7, and it is possible to dispense parts for fixing these components, and thus, to provide an arrester which is made into a compact size.

[0048] Even if the non-linear resistor 1 causes a through breakdown by an excessive operation, an arc is generated, and simultaneously, a gas is generated. An internal pressure rises, the surrounding of the non-linear resistor 1 is covered with the insulative woven fabric 4, and therefore, it is possible to prevent the arrester from being explosively scattered. Moreover, the non-linear resistor 1 is joined, and then, no partial discharge is generated therein. Thus, it is possible to prevent the insulator 7 made of a polymer resin from being deteriorated.

[0049] Moreover, as mentioned above, each terminal electrode 2 joined to both upper and lower end portions of the non-linear resistor 1 is formed with the upper surface (outside) portion 5. The end portion of the insulative woven fabric 4 covering the internal element 3 is held between the upper surface portion 5 and the holding metal fitting 6, and then, is fastened and fixed by the holding metal fitting 6 so that an axial stress is applied

to the internal element 3. Therefore, even if the non-linear resistor 1 causes a through breakdown by an excessive operation of the arrester which is rarely generated, a gas is generated by a generation of an arc and an internal pressure rises up, a gas diametrically blows out of the polymer resin portion of a net portion of the insulative woven fabric 4, and then, the insulator 7 made of polymer resin is merely partially broken. Therefore, it is possible to prevent the arrester from being explosively scattered.

[0050] The insulative woven fabric 4 is made in a manner that an insulative thermosetting resin such as an epoxy resin, a polyester resin or the like is impregnated in an insulative fabric comprising a warp and weft such as a glass fiber, and therefore, the insulative woven fabric 4 can be readily manufactured at a low cost. Further, the insulative woven fabric 4 is formed into a cylindrical shape. Thus, a plurality of non-linear resistors 1 and terminal electrodes 2 are successively inserted into the insulative woven fabric 4 formed into a cylindrical shape. Therefore, an assembling work can be simplified, and also, a productivity can be improved.

[0051] Moreover, both the end portions of the cylindrical insulative woven fabric 4 are folded over the upper surface portions 5 of the terminal electrodes 2 and then fixed by the holding metal fitting 6. The end portion of the insulative woven fabric 4 is fastened and fixed by using the holding metal fitting 6. Further, since the upper surface portion 5 is formed with the R-portion 9, a work for winding the insulative woven fabric 4 is easy and the joined state is preferable.

[0052] Likewise, in a case of a sheet-like insulative woven fabric, the sheet-like. insulative woven fabric is wound around the internal element 3 two or three times, and thereafter, an end portion of the sheet-like insulative woven fabric is fixed, and the non-linear resistor 1 and the terminal electrode 2 are integrated with the insulative woven fabric so that an axial stress is applied thereto.

[0053] In a single yarn or twist yarn constituting the insulative woven fabric 4, each angle from two different directions is set to a range from 30 to 160°, and thereby, a sufficient strength can be obtained. The angle is preferably 60°. If the angle is less than 30°, or exceeds 160°, a fiber slips, and a sufficient strength can not be obtained.

[0054] An interval of a single yarn or twist yarn is set to a range from 0.5 to 5 mm, so that a preferable pressure releasing characteristic and a sufficient strength can be obtained. If the interval exceeds 5 mm, a sufficient strength can not be obtained. Further, if the interval is less than 0.5 mm, a generated gas is not released and an improved effect is not obtainable.

[0055] The insulative woven fabric 4 is provided with a weak-point portion for pressure release at a position in the vicinity of the upper and lower edge portions of the non-linear resistor 1 formed in a manner that plural non-linear resistors are laminated. The weak-point portion includes a pressure release opening, a folded portion of the insulative woven fabric 4, a notch portion of the insulative woven fabric 4, a portion in which fiber is coarsely woven and an insulating resin portion thinner than other portions. By doing so, in a case where an arc is generated by an excessive operation of the arrester, a short-circuit current flows through the non-linear resistor 1, the insulative woven fabric 4 or an interface of the insulator 7. Then, the generated arc flows the upper and lower terminal electrodes via the opening portion or the weak-point portion of the insulative woven fabric 4, and simultaneously, a gas generated in the non-linear resistor is vertically released. As a result, even if an excessive current flows, the non-linear resistor 1 can be held in the insulative woven fabric 4, and thereby, it is possible to prevent the arrester from being explosively scattered.

[0056] The insulator 7 made of polymer resin contains a filler by 0.5 to 40%, and thereby, an elasticity as polymer resin is kept while the weather resistance being improved. A content of the filler is preferably of 20 to 38%, and if the content of filler is less than 0.5%, 24 hours takes to recover a water repellent performance of the insulator 7 made of polymer resin, and the weather resistance is not improved. Further, if the content of filler exceeds 40%, an elasticity of the insulator made of polymer resin is lost.

[0057] The insulator 7 made of polymer resin contains Pt, Fe, Ni, Ca, Mn, Na, K and Mg as a catalyst by 1 to 50ppm, so that an elasticity as polymer resin is kept while the weather resistance being improved. A content of the catalyst is preferably 5 to 30ppm, and if the content of the catalyst is less than 1ppm, 20 hours takes to recover a water repellent performance of the insulator 7 made of polymer resin. For this reason, the weather resistance is not improved. Further, if the content of the catalyst exceeds 50ppm, an elasticity of the insulator 7 made of polymer resin will be lost.

[0058] Moreover, since the polymer resin has a rubber hardness of 30 to 60, it is possible to improve a dust resisting characteristic. In this case, if the rubber hardness is less than 30, it is difficult to maintain a shade-shape of the insulator. If the rubber hardness exceeds 60, the insulator is made easy to be damaged. Since the polymer resin has a low molecular weight of 2000 to 8000, it is possible to obtain the preferable short-circuit characteristic and the weather resistance. In this case, if the polymer resin has a molecular weight of 2000 or less and if it exceeds a molecular weight of 8000, it is impossible to obtain both the preferable short-circuit characteristic and weather resistance.

[0059] A tracking resistance of the polymer resin is set to 3.5 to 5.5kV, so that it is possible to obtain the preferable short-circuit characteristic and the weather resistance. In this case, if the tracking resistance is less than 3.5kv, during the weather resistance test, a leakage current on the surface of pleat portion of the insulator 7 increased, and it has found that there is a problem

in a lifetime characteristic. Moreover, if the tracking resistance exceeds 5.5kV, during the weather resistance test, a generation of corona discharge has been confirmed.

[0060] In the polymer resin, a ratio of a main liquid to a hardening agent ranges from 1:0.9 to 1:1.1; therefore, a mixing condition is made preferable. The ratio is preferably of 1:1, and if it diverges from a range from 1:0.9 to 1:1.1, a desirable mixing condition is not obtainable.

[0061] Next, a manufacturing method of an arrester of this embodiment will be described hereunder with reference to Fig. 2A, 2B and 2C.

[0062] First, as shown in Fig. 2A, a plurality of non-linear resistors 1 consisting mainly of a zinc oxide are conductively joined by using a conductive bonding agent, and then, are vertically laminated or stacked in series. Further, terminal electrodes 2 are conductively joined to upper and lower end portions of the laminated non-linear resistors by the conductive bonding agent, and thus, an internal element 3 is formed.

[0063] Next, as shown in Fig. 2B, the internal element 3 is covered with an insulative woven fabric 4 in which an insulating resin hardened by being heated is impregnated, and thus, the internal element 3 and the insulative woven fabric 4 are integrated.

[0064] Thereafter, the internal element 3 thus integrated is arranged in a mold 10 which is formed with a shade-like cavity as shown in Fig. 2C, and then, a polymer resin mixed with the main liquid, the hardening agent and the coloring agent is injected in the mold 10 from an injection molding machine 11 via an inlet port 10a. The polymer resin is hardened in the mold 10 so as to form an insulator 7, and thereby, the arrester of this embodiment is obtained.

[0065] In this case, in the injection molding machine 11, the main liquid, the hardening agent and the coloring agent are supplied from a main liquid tank 12 storing the main liquid, a hardening agent tank 13 storing the hardening agent and a coloring agent tank 14 storing the coloring agent to a pipe-like mixing container 16 by a feed pump 15. The main liquid, hardening agent and coloring agent are mixed by passing through the pipe-like mixing container 16, and thereafter, are injected into the mold 10. As shown in Fig. 3, the pipe-like mixing container 16 is provided with a plurality of rotating blades 17 for mixing. An extra polymer resin injected into the mold 10 is sucked through a discharge port 10b by a suction means such as a vacuum pump or the like.

[0066] It is desirable that a surface of the integral product covered integrally with the insulative woven fabric 4 is previously subjected to a primer treatment before molding a polymer resin. By doing so, a polymer resin is easy to be joined to the integrated product.

[0067] The main liquid tank 12 stores the polymer resin, a catalyst such as Pt, and a filler such as SiO_2, TiO_2 or the like. The hardening agent tank 13 stores a polymer resin and a hardening agent such as RSiX (R = methyl group, X = methoxy group, etc.).

[0068] In the polymer resin injected to the mold 10, a ratio of the main liquid to the hardening agent is 1: 0.9 to 1:1.1, and the coloring agent is added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%. The coloring agent uses any one of dimethyl silicon, titanium and carbon as a main component.

[0069] As described above, according to the manufacturing method of the arrester of this embodiment, the terminal electrodes 2 are conductively joined to both the end portions of the laminated non-linear resistor 1 so as to construct the internal element 3, and then, the surrounding of the internal element 3 is covered with the insulative woven fabric 4 in which an insulating resin hardened by being heated is impregnated so that the internal element 3 and the insulative woven fabric 4 are integrated. Thereafter, the internal element 3 thus integrated is arranged in the mold, and then, the polymer resin mixed with the main liquid, the hardening agent and the coloring agent is injected into the mold 10 from the injection molding machine 11, and thus, is hardened in the mold 10 so as to form an insulator 7. Therefore, it is possible to improve a manufacturing efficiency and to manufacture the arrester having a high quality.

[0070] Moreover, according to the manufacturing method of the arrester of this embodiment, the coloring agent is added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%, and thereby, the insulator is colored. Therefore, it is possible to protect an internal portion of the lightning arrester from an ultraviolet ray. In this case, if the coloring agent is less than 0.05wt%, an effect as a coloring agent is not obtained, and if it exceeds 2.0wt%, there is a tendency for the weather resistance to deteriorate.

[0071] Concrete or detailed examples of the present embodiment will be described hereunder.

[First Example]

[0072] Three non-linear resistors 1 consisting mainly of a zinc oxide and having a diameter of 30 mm and a height of 30 mm, and two terminal electrodes 2, which are formed with screw portions 8 and have a predetermined shape, were laminated via a low melting point metal, and then, the non-linear resistor 1 and the terminal electrodes 2 were joined through heating. Then, a glass fiber was used as a twist yarn having a diameter of approximately 0.5 mm, and a cylindrical woven fabric having no seam in a circumferential direction was previously made. An angle constituted by the twist yarn was set to 60° and an interval was set to 3 mm.

[0073] The woven fabric thus made was impregnated with an epoxy resin, and then, was cut into a predetermined length, and thereafter, the non-linear resistor 1 was inserted thereinto. An end portion of the

insulative woven fabric 4 was fastened to the terminal surface, and then, was fixed thereon by a nut which is a holding metal fitting 6.

[0074] The non-linear resistor unit thus integrated was heated at a temperature of 160° for an hour, and then, is covered with an epoxy resin which is an insulating resin. The non-linear resistor unit was subjected to a primer treatment, and thereafter, was set in the mold 10 which is formed with a shade-like cavity. Then, the polymer resin was supplied to the mold 10 from the injection molding machine 11 so that a ratio of the main liquid to the hardening agent becomes 1:1 and was mixed by passing through the pipe-like mixing container 16 having a plurality of rotating blades 17 for mixing so that a bubble does not enter therein, and thus, the polymer resin was injected into the mold 10 through an inlet port 10a. Further, the polymer resin was hardened by being heated at a temperature of 160° C for two hours so as to obtain an arrester. In this case, an extra polymer resin injected to the mold 10 was sucked through the discharge port 10b.

[0075] In this first example, a silicon resin consisting mainly of dimethyl polysiloxan was used as the polymer resin.

[0076] A short-circuit test was performed with respect to the arrester thus manufactured according to the arrester international standards (IEC60-99-4(1999)). The test was made in the following manner that a voltage of 1.1 times as much as an operation start voltage of the arrester was applied for 5 to 10 minutes, and thereafter, a short-circuit current was electrically energized. In this test, even when a short-circuit current of 34kA flows, no explosive scattering was generated, and the non-linear resistor 1 was not scattered. Thus, a preferable result was obtained. Although the arrester of this example is 5kA class, and 5kA in the standards, it was confirmed that the arrester of this example is applicable to class more than the above-described 5kA class.

[0077] In the arrester of this first example, the non-linear resistor 1 was joined and hardened by the insulating resin so as to be integrated with the insulative woven fabric as a unit, and thus, these components were collectively molded out of a polymer resin. Therefore, it is possible to provide an arrester which has a compact size and is excellent in pressure releasing characteristic.

[0078] Further, in the arrester of this first example, an angle of the twist yarn constituting the insulative woven fabric 4 is set to 60°. In the case where the angle is set to a range from 30° to 160°, it was confirmed that a preferable result was obtained. If the angle is set to 30° or less and 160° or more, a fiber slips, and a sufficient strength can not be obtained.

[0079] Furthermore, in the arrester of this first example, an interval of the twist yarn is set to 3 mm. In the case where the interval is set to a range from 0.5 to 5 mm, a preferable pressure releasing characteristic was obtained, likewise. In this first example, the twist yarn having a diameter of 0.5 mm was used. This first example is not limited to this twist yarn, and it was confirmed that the same effect was obtained in the case where a single yarn was used.

[0080] The non-linear resistor 1 and the terminal electrodes 2 are directly joined, and therefore, in this first example, no partial discharge is generated and a deterioration is not confirmed in the polymer resin. As a result, a preferable arrester can be obtained.

[0081] In this first example, a silicon resin consisting mainly of dimethyl polysiloxan has been used. In place of a methyl group, in the case where the same arrester is manufactured by using other alkyl and phenyl group silicon resins, the same effect will be obtainable.

[0082] The mixing condition is the most preferable when a ratio of the main material to the hardening agent of the silicon resin is 1:1. It was confirmed that the same effect can be obtained when the hardening agent has a range from 90% to 110% with respect to the main material.

[0083] In the case where the coloring agent is added by 2% or less with respect to the silicon material, it was confirmed that the same effect can be obtained.

[Second Example]

[0084] In this second example, like the above-described first example, the non-linear resistor 1 and the terminal electrodes 2 were joined, and then, a cylindrical woven fabric was previously made of a glass fiber, like the first example. An interval of twist yarn was shortened in its appearance. The woven fabric was impregnated with an epoxy resin, and then, was cut into a predetermined length, and thereafter, the non-linear resistor 1 was inserted thereinto. The joined non-linear resistor 1 was formed with an opening portion having a diameter of 2 mm in the vicinity of the peripheral edge portion of the uppermost and lowermost surface. An arrester was manufactured in the same manner as that of the first example.

[0085] Like the first example, a short-circuit test was carried out with respect to the arrester thus manufactured, and as a result, even if a short-circuit current be 38kA, a preferable result was obtained with no explosive scattering and the non-linear resistor 1 was not scattered.

[0086] In this second example, even if the insulative woven fabric is woven in a state that its stitch is shortened, the laminated non-linear resistor 1 is formed with an opening portion at the upper and lower end portions, and therefore, in the case where an arc is generated by an excessive operation of the arrester, a short-circuit current flows through the non-linear resistor 1, the insulative woven fabric 4 or the interface of the insulator 7, and then, the generated arc flows through the upper and lower terminal electrodes 2 via the opening portion of the insulative woven fabric 4 while vertically releasing

a gas generated in the interior. As a result, even if an excessive current flows, the non-linear resistor 1 can be held in the insulative woven fabric 4, and therefore, it is possible to prevent the non-linear resistor 1 from explosively scattered.

[0087] In place of the above-described opening portion, a weak-point portion may be formed. That is, the weak-point portion includes a folded portion, a notch portion, a portion where a glass fiber is coarsely woven, and an insulating resin portion thinner than other portions. By doing so, it was confirmed that the same characteristic can be obtained.

[Third Example]

[0088] In this third example, like the above-described first example, the non-linear resistor 1 and the terminal electrodes 2 were joined so as to be integrated with the insulative woven fabric 4, and thereafter, were subjected to a primer treatment, and further, SiO_2 was previously added by 40% to a silicon resin as a filler and thus, the same arrester as the above-described first example was manufactured.

[0089] A short-circuit test was performed with respect to the arrester thus manufactured, like the above-described first example. As a result, even if a short-circuit current is 33kA, no explosive scattering was generated, and also, the non-linear resistor 1 was not scattered, and therefore, a preferable result can be obtained. Moreover, in this third example, it was confirmed that the weather resistance was improved. More specifically, the test was carried out in such a manner that a working voltage was applied for 1000 hours while spraying salt water, and thereafter, a distilled water was dropped on a polymer shade which is an insulator 7. Further, a contact angle was measured, and then, a recovery time to the initial value was compared, and thus, a water repellent performance was evaluated.

[0090] As a result, in this third example, the recovery time was two hours, and on the contrary, in order to make a comparison, in the above-described first example, the recovery time was over 24 hours. Therefore, it was confirmed that the weather resistance was improved in this third example.

[0091] Even if TiO_2 was added by 40% inn place of SiO_2, it was confirmed that the same effect could be obtained. Moreover, if SiO_2 or TiO_2 was added by 40% or more, a characteristic as a rubber of the polymer was lost, and then, a strength was lowered, and for this reason, an improvement effect could not be obtained.

[0092] Pt was previously added to a silicon resin, and then, an arrester was manufactured in the same manner. Then, a short-circuit test was carried out with respect to the arrester thus manufactured. As a result, even if a short-circuit current be 38kA, the same preferable effect can be obtained.

[0093] In the weather resistance test, a recovery time was 2 hours, and a preferable result was obtained. Moreover, in place of PT, Fe, Ni, Ca, Mn, Na, K and Mg were added to a silicon resin by 50ppm, and then, an arrester was manufactured. An evaluation was made in the same manner. As a result, the same preferable result can be obtained in a short-circuit test and the weather resistance test. If an added amount exceeds 50ppm, a characteristic as a rubber of the polymer was lost, and then, a strength was lowered, thus an improved effect could not be obtained.

[Fourth Example]

[0094] In this fourth example, like the above-described first example, the non-linear resistor 1 and the terminal electrodes 2 were joined so as to be integrated with the insulative woven fabric 4, and thereafter, were subjected to a primer treatment. A polymerization degree of silicon resin was adjusted in advance, and thus, a polymer material having a molecular weight of 3500 was obtained. The same arrester as the above-described first example was manufactured.

[0095] A short-circuit test was performed with respect to the arrester thus manufactured, like the above-described first example. As a result, even if a short-circuit current be 40kA, no explosive scattering was generated, the non-linear resistor was not scattered, and a preferable result can be obtained. Moreover, in this fourth example, it was confirmed that the weather resistance was improved. That is, the test was performed in the manner that a working voltage was applied for 1000 hours while spraying salt water, and thereafter, a distilled water was dropped on a polymer shade which is an insulator 7. Further, a contact angle was measured, and then, a recovery time to the initial value was compared, and thus, a water repellent performance was evaluated. In this fourth example, a recovery time was 0.5 hours, and it was confirmed that the weather resistance was further improved. A polymerization degree of silicon resin was changed from 2000 to 8000, and then, the silicon resin was prepared. Thereafter, an arrester was manufactured in the same manner, and then, was evaluated. As a result, it was confirmed that the same preferable short-circuit characteristic and the weather resistance can be obtained.

[Fifth Example]

[0096] In this fifth example, like the above-described first example, a silicon heating temperature and a silicon heating time were adjusted via a process until silicon resin injection, a silicon rubber hardness was set to 30 to 60, and then, an arrester was manufactured.

[0097] A short-circuit test was performed with respect to the arrester thus manufactured, like the above-described first example. As a result, even if a short-circuit current be 36kA, no explosive scattering was generated, and the non-linear resistor was not

scattered, and therefore, a preferable result could be obtained. Moreover, in a weathering resistance test, a recovery time was 1.5 hours. Thus, a preferable result can be obtained. In this fifth example, it was confirmed that a dust resistance characteristic was improved. More specifically, a blast test was carried out in WA#240, and as a result, in the case where a rubber hardness is less than 60, a dust particle was repelled by an elasticity. On the contrary, in the case where the rubber hardness exceeds 60, the arrester received an impact by the dust particle, and then, was damaged. In the case where the rubber hardness is less than 30, the shade-shape was not maintained, and the arrester was not suitable.

[Sixth Example]

[0098] In this sixth example, like the above-described first example, a silicon heating temperature and a silicon heating time were adjusted via a process until silicon resin injection, a tracking resistance characteristic of a silicon resin was set to 3.5kV or more, and then, a arrester was manufactured.

[0099] A short-circuit test was performed with respect to the arrester thus manufactured, like the above-described first example. As a result, even if a short-circuit current be 36kA, no explosive scattering was generated, the non-linear resistor was not scattered, and therefore, a preferable result could be obtained. Moreover, in the weather resistance test, a recovery time was 1.5 hours. Thus, a preferable result could be obtained.

Claims

1. An arrester comprising:

   at least one of non-linear resistor mainly consisting of a zinc oxide;
   terminal electrodes disposed to both end portions of the non-linear resistor to be electrically conductive so as to construct an internal element;
   an insulative woven fabric impregnated with an insulation resin which is hardened by being heated, said insulative woven fabric being applied so as to surround the internal element; and
   a polymer resin integrally molded to the internal element surrounded by the insulative woven fabric.

2. An arrester according to claim 1, wherein the insulative woven fabric is formed into a tubular shape by weaving an insulative single yarn or twist yarn to be continuous endlessly in a circumferential direction thereof.

3. An arrester according to claim 2, wherein the single yarn or twist yarn constituting the insulative woven fabric has an angle, from two different directions, is set to a range from 30 to 160°.

4. An arrester according to claim 2, wherein a weaving interval of the single yarn or twist yarn constituting the insulative woven fabric is set to a range from 0.5 to 5 mm.

5. An arrester according to claim 1, wherein the insulative woven fabric is formed with a pressure releasing opening portion at a position in a vicinity of axially upper and lower peripheral edge portions of the non-linear resistor.

6. An arrester according to claim 1, wherein the insulative woven fabric is formed with a pressure releasing weak-point portion at a position in a vicinity of axially upper and lower peripheral edge portions of the non-linear resistor.

7. An arrester according to claim 1, wherein the polymer resin contains a filler by 0.5 to 40 weight %.

8. An arrester according to claim 7, wherein the filler is made of at least one of SiO_2 and TiO_2.

9. An arrester according to claim 1, wherein the polymer resin contains Pt, Fe, Ni, Ca, Mn, Na, K and Mg by 1 to 50ppm.

10. An arrester according to claim 1, wherein the polymer resin has a rubber hardness of 30 to 60.

11. An arrester according to claim 1, wherein the polymer resin has a low molecular weight of 2000 to 8000.

12. An arrester according to claim 1, wherein the polymer resin has a tracking resistance of 3.5 to 5.5kV.

13. An arrester according to claim 1, wherein the polymer resin comprises a main liquid and a hardening agent in a ratio of the main liquid to the hardening agent ranging from 1:0.9 to 1:1.1.

14. An arrester according to claim 1, wherein the polymer resin comprises a main liquid, a hardening agent and a coloring agent, said coloring agent being added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%.

15. A method of manufacturing an arrester comprising the steps of:

    preparing at least one non-linear resistor

mainly consisting of a zinc oxide and terminal electrodes;
conductively joining the terminal electrodes to both end portions of the non-linear resistor so as to construct an internal element;
covering a surrounding of the internal element with an insulative woven fabric which is impregnated with an insulating resin hardened by being heated so that the internal element and the insulative woven fabric are integrated;
arranging the integrated internal element in a mold;
injecting a polymer resin mixed with a main liquid, a hardening agent and a coloring agent into the mold; and
hardening the polymer resin in the mold so as to form an insulator.

16. A manufacturing method of an arrester according to claim 15, wherein said injection molding is carried out by using an injection molding machine including material tanks in which the main liquid, the hardening agent and the coloring agent are stored and including a mixing container into which the main liquid, the hardening agent and the coloring agent are mixed, said mixing container having a tubular structure in which a plurality of rotating blades are disposed.

17. A manufacturing method of an arrester according to claim 15, wherein a surface of an integrated product formed by covering the surrounding of the internal element with the insulative woven fabric, which is impregnated with the insulating resin hardened by being heated, is previously subjected to a primer treatment before molding the polymer resin.

18. A manufacturing method of an arrester according to claim 15, wherein the polymer resin comprises a main liquid and a hardening agent in a ratio of the main liquid to the hardening agent ranging from 1:0.9 to 1:1.1.

19. A manufacturing method of an arrester according to claim 15, wherein the polymer resin comprises a main liquid, a hardening agent and a coloring agent, said coloring agent being added by 0.05 to 2.0wt% with respect to the main liquid of 100wt% and the hardening agent of 100wt%.

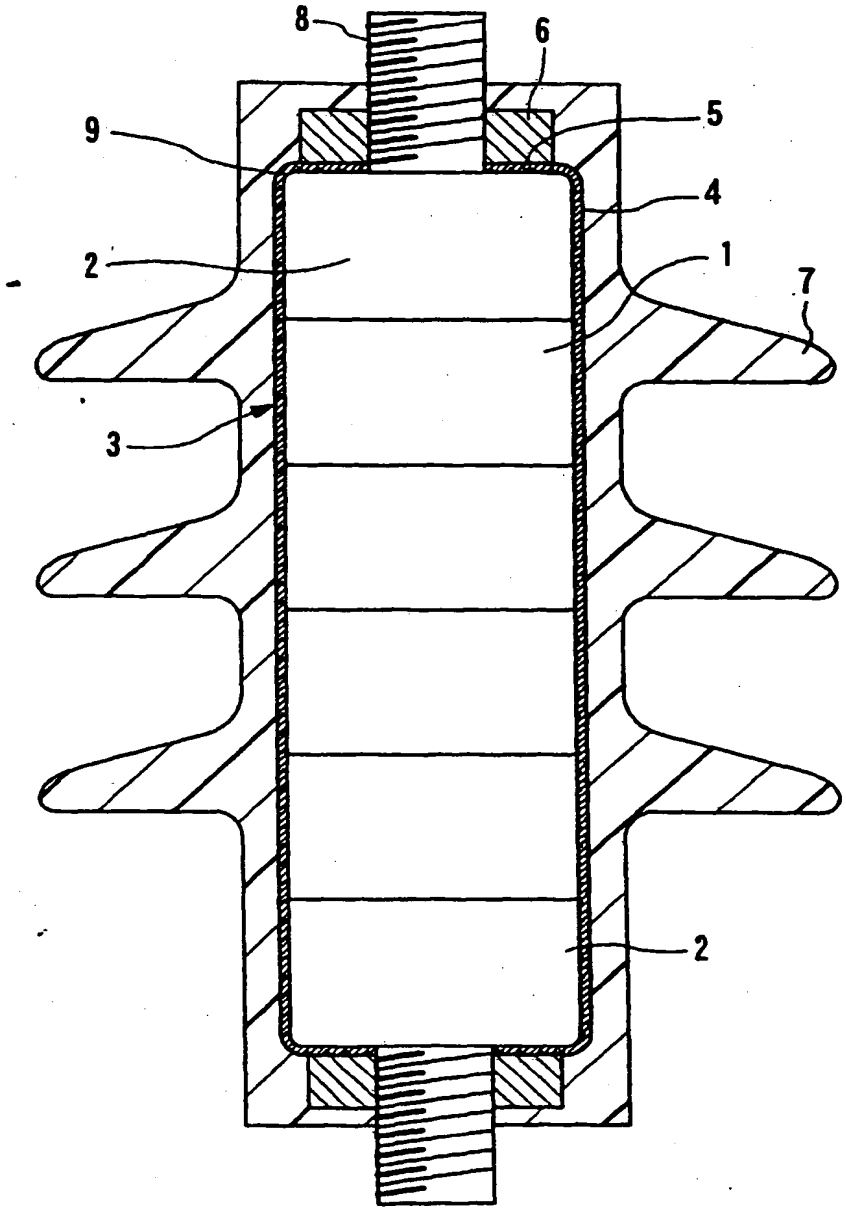

FIG. 1

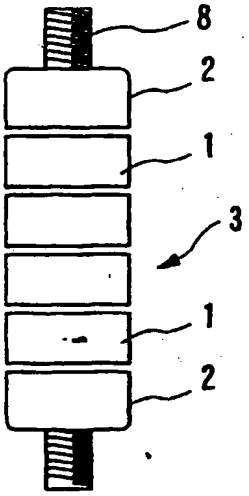

FIG. 2A

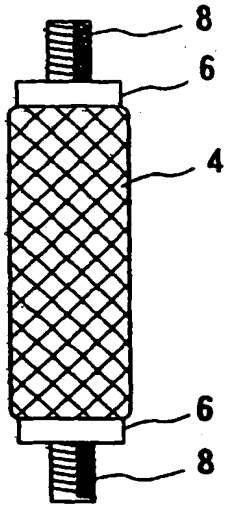

FIG. 2B

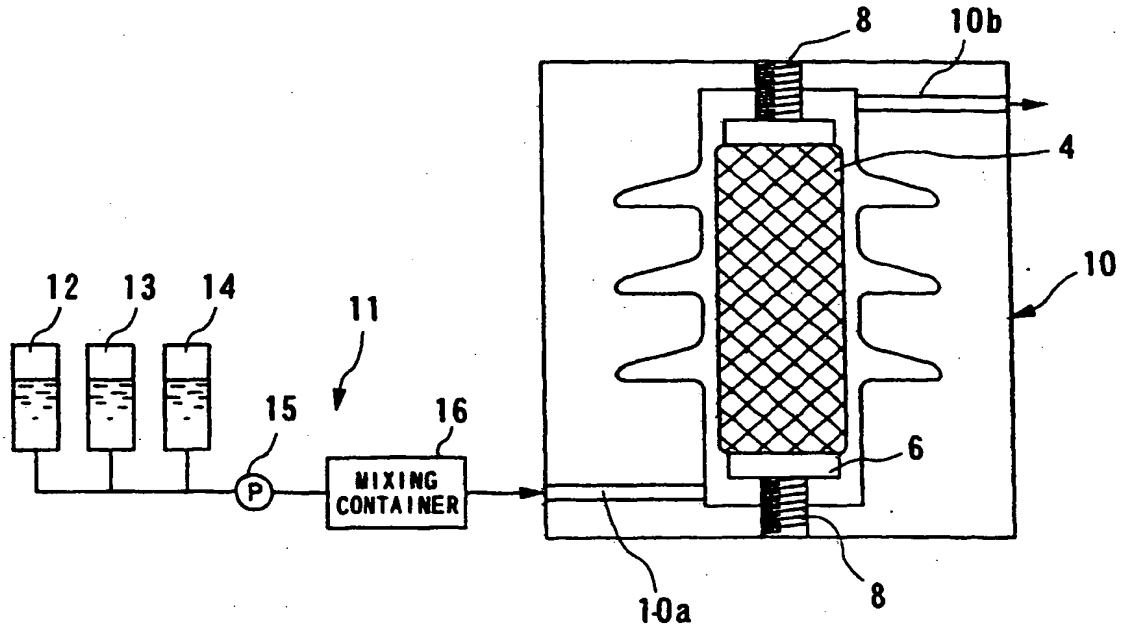

FIG. 2C

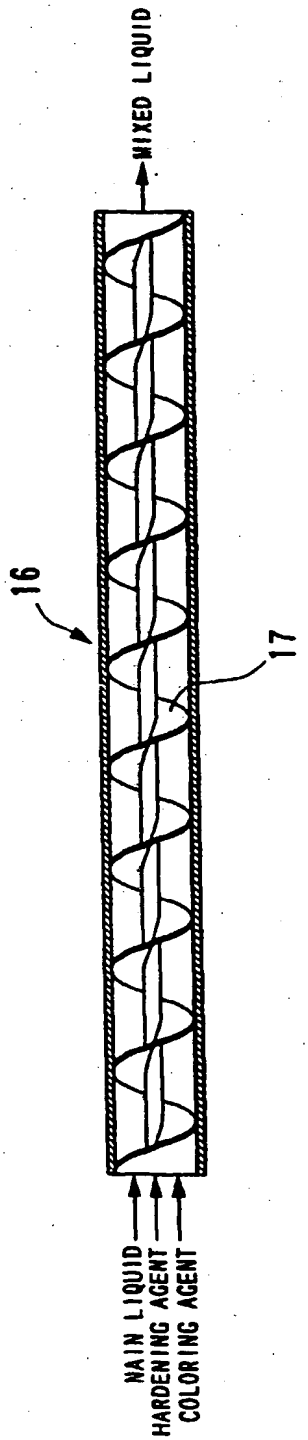
MIXED LIQUID
16
17
MAIN LIQUID
HARDENING AGENT
COLORING AGENT

FIG. 3

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(54) Arrester and manufacturing method thereof

(57) An arrester comprises at least one of non-linear resistors (1) mainly consisting of a zinc oxide, terminal electrodes (2) disposed to both end portions of the non-linear resistor (1) to be electrically conductive so as to construct an internal element (3), an insulative woven fabric (4) impregnated with an insulation resin which is hardened by being heated, the insulative woven fabric (4) being applied so as to surround the internal element (3), and a polymer resin integrally molded to the internal element (3) surrounded by the insulative woven fabric (4). The arrester is manufactured by conductively joining the terminal electrodes (2) to both end portions of the non-linear resistor (1), covering a surrounding of the internal element (3) with an insulative woven fabric (4), arranging the integrated internal element (3) in a mold, injecting a polymer resin mixed with a main liquid, a hardening agent and a coloring agent into the mold, and hardening the polymer resin in the mold so as to form an insulator.

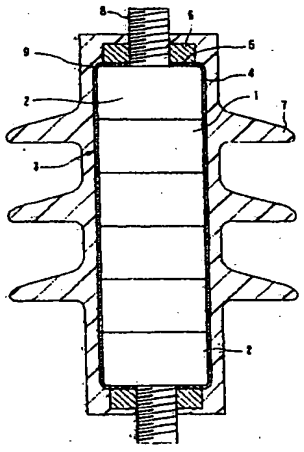

FIG. 1

EP 1 067 565 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 00 11 4655

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 March 2002	Kirkwood, J

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